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Notes on *Stereocaulon* species from Bolivia

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Abstract — *Stereocaulon crambidiocephalum*, *S. pachycephalum*, and *S. pomiferum* are reported as new to Bolivia. Notes on the recently discovered holotype of *S. meyeri* are included.

Key words — lichenized fungi, lichen metabolites, Neotropics, taxonomy

Introduction

The genus *Stereocaulon* Hoffm. (*Stereocaulaceae*, *Lecanorales*, lichenized *Ascomycota*) is represented by about 29 species in the Neotropics (Lamb 1977, 1978, Boekhout 1982, Sipman 1986, Weber 1986, Marcano et al. 1995, Sipman 2002). Although some neotropical countries are reasonably well studied, many, including Bolivia, have been only partially explored. However, the investigation of the lichen flora of Bolivia in recent years has made considerable progress (e.g. Flakus & Wilk 2006, Flakus 2008, Flakus & Lücking 2008, Flakus et al. 2008, 2011, 2012; Knudsen & Flakus 2009, Kukwa & Flakus 2009, Flakus & Kukwa 2012, Knudsen et al. 2012) and, among many others, several collections of *Stereocaulon* have become available. According to Rodriguez et al. (2012), 13 *Stereocaulon* species (four with intraspecific taxa) have been reported from Bolivia; some of these are known only from old records, which should be revised.

After an examination of the recently collected material and relevant literature, it appeared that three species have not been previously reported from Bolivia. In case of *S. meyeri*, a taxon already known from the country, notes of the recently discovered holotype are provided. This paper provides information on these taxa, thereby expanding our knowledge of lichen diversity in Bolivia and of *Stereocaulon* in particular.

Material & methods

Material from KRAM, LPB, and UGDA was studied and compared with specimens deposited in BM, H, H-ACH, H-NYL, LOD, UPS, and WRSL. Morphological characters (i.e. thickness, morphology and colour of thallus; shape of phyllocladia; presence, shape and size of cephalodia) were examined using a stereomicroscope. Cyanobacteria in cephalodia were examined under a light microscope and determined to the genus level. Chemical analyses were performed by thin-layer chromatography (TLC) in solvents A and C according to the methods of Culberson & Kristinsson (1970) and Orange et al. (2001). The descriptions and chemical compounds presented below are based on our own observations.

Most authors (e.g. Lamb 1977, 1978, Boekhout 1982, Sipman 2002) use the term phyllocladia for all types of thalline outgrowths present on pseudopodetia; however, if they are coralloid, the term phyllocladial (or pseudopodetial) branchlets should be applied (see Lamb 1951, 1978, Boekhout 1982)

The taxa

Stereocaulon crambidiocephalum I.M. Lamb, J. Hattori Bot. Lab. 43: 290. 1977.

Morphology — Primary thallus persistent. Pseudopodetia 4–5 cm tall, erect, coarse, not or little branched at the base, attenuated towards the apex, decorticated. Phyllocladial branchlets present only on the lower part of the pseudopodetia, coralloid. Cephalodia sacculate, concolorous with the pseudopodetia to grey, containing *Rhizonema* (previously referred to as *Scytonema*; see Lücking et al. 2009). Soralia present, capitate, developing on minute congested corymbose branchlets, terminal on the pseudopodetia.

Chemistry — Atranorin and perlatolic acid (in accordance with Lamb 1977).

Distribution and habitat — *Stereocaulon crambidiocephalum* is a rare species, known only from the Neotropics in Colombia, Costa Rica, Peru, and Venezuela (Lamb 1977, Boekhout 1982, Sipman 1992, Umaña-Tenorio et al. 2002, Sipman et al. 2008). In this paper we report the first localities from Bolivia, where it was found on rocks at 3800–4100 m altitudes in open habitats.

Specimens examined — **BOLIVIA. Dept. La Paz.** Prov. Inquisivi, Barrancos de Sayaquita, cliffs north of the road between Pongo and Sayaquita, c. 1 km E of Sayaquita, 67°16′W 17°00′S, c. 3800 m, 09.07.1986, Lewis 66-172 (LPB); Prov. Murillo, near Cumbre Pass, 16°19′18″S 68°04′42″W, 4550 m, high Andean Puna vegetation, 17.06.2006, Flakus 8522,1 (KRAM, LPB); Prov. Tamayo, Comunidad Klara (nueva), desde el pueblo cruzando el Río Jatun Kuchu, subiendo la ladera en dirección norte, 14°41′S 69°05′W, 4100 m, 17.06.2005, Jimenez, Fuentes 2772 (LPB).

Notes — *Stereocaulon crambidiocephalum* resembles *S. meyeri* in chemistry and morphology but can be distinguished by its large apical heads of soredia borne on fine congested branchlets; in *S. meyeri* soredia develop directly on the main pseudopodetial branches (Lamb 1977, 1978) and do not form apical heads.

Stereocaulon meyeri Stein, Jahresber. Schles. Ges. Vaterl. Cult. 66: 134. 1888.

Type: Tanzania, Mt. Kilimanjaro, altit. 4000 m, 01.09.1887, Meyer (WRSL! – holotype).

Morphology — Primary thallus disappearing. Pseudopodetia up to 7 cm tall, erect or creeping with ascending tips, not or little branched at the base, towards the apex attenuated, glabrous or tomentose, pale ochraceous to greyish. Phyllocladial branchlets present sometimes only on the upper side of the pseudopodetia, coralloid or tending to palmate, greyish-green. Cephalodia sacculate, pale to ash grey, containing *Rhizonema* (previously referred to as *Scytonema*; see Lücking et al. 2009). Soralia present, terminal on the pseudopodetia, finely granular.

Chemistry — Atranorin and perlatolic acid (in accordance with Lamb 1977).

Distribution and habitat — The distribution of *S. meyeri* is restricted to the Neotropics, southern South America, and Africa (Lamb 1977). In the Neotropics, it has been reported previously from Bolivia (but only from a single locality), Peru, Ecuador, Colombia, Venezuela, and Mexico (Lamb 1977, Boekhout 1982, Feuerer et al. 1998, Sipman et al. 2008). In Bolivia the species was found on rocks in high mountains from 3700 m upwards.

Additional specimens examined — **BOLIVIA. Dept. La Paz.** Prov. Murillo, Cordillera Real, Valle de Zongo, Laguna Viscachani, 3800 m, orilla de la laguna, zona de rocas grandes, vegetación tipo Puna, 27.08.1988, Stab LB 157 (LPB); Rio Minasa, area of Rio Minasa at river forks in Villa Urkupiña, c. 1.5 km N of the old rail road bridge in Villa Condoriri, c. 5 km E of N from Plana San Francisco (La Paz), 16°27′S 68°08′W, c. 3980 m, semi-humid grasslands with *Polylepis*, 1987, Lewis 87-024 (LPB); Prov. Inquisivi, Molinos, near the mouth of the Rio "Pusi Khota" c. 1 km down river from Sayaquita, 1 km S of Estancia Villa El Carmen, 67°16′S 17°00′W, c. 3700 m, 08.07.1986, Lewis 86-120 (LPB).

Notes — Lamb (1977) examined only one specimen sent by B. Stein to Th. Fries (in UPS) and referred to as isotype in his paper. The original specimen was supposed by Lamb (1977) to be preserved in WRSL (as BRSL in his paper), where it has recently been found. We propose here to treat the specimen in WRSL as holotype, because H. Meyer most probably collected only one specimen in Tanzania, which was later divided by Stein, who sent a part to Fries. Lamb (1977) correctly regarded the UPS sample as isotype.

Stereocaulon meyeri is morphologically similar to *S. crambidiocephalum* and *S. ramulosum* (Sw.) Raeusch. (See under *S. crambidiocephalum* for comparison with that species.) The only difference between *S. meyeri* and *S. ramulosum* is the production of soralia, present in the former but absent in the latter (Lamb 1977). Whether *S. meyeri* represents only a sorediate form of *S. ramulosum* should be determined by molecular analysis.

Stereocaulon pachycephalum Vain., Dansk Bot. Ark. 4(11): 7. 1926.

Morphology — Primary thallus disappearing. Pseudopodetia to 6 cm tall, not branched at the base or with a few erect branches, with short branchlets in the upper part, sometimes dichotomously branched, when young corticated, when mature decorticated at the base, medially in different stages of decortication, and in the upper part corticated, greenish-grey. Phyllocladial branchlets present, coralloid or slightly palmate, with a surface made uneven by furrows, with pseudosoredial granules, greenish-grey, sometimes with a pale underside. Cephalodia sacculate, clavate to globose, sometimes flattened, pale to dirty grey, containing *Rhizonema* (previously referred to as *Scytonema*; see Lücking et al. 2009). Apothecia of lecideine appearance, terminal on the pseudopodetia.

Chemistry — Atranorin, fumarprotocetraric and perlatolic acids (in accordance with Lamb 1977, deficient phase II).

Distribution and habitat — This species is restricted to the Neotropics from Ecuador, Colombia, Venezuela, Peru, and Mexico (Lamb 1977, Boekhout 1982, Sipman 1992, Sipman et al. 2008). We report it here for the first time from Bolivia, where it was found on the ground at a 3050–3810 m altitude.

Specimens examined — **BOLIVIA. Dept. La Paz.** Prov. Nor Yungas, Cotapata, 16°17′S, 67°51′W, 3050 m, bosque altomontano, alterado, s.coll. (LPB); 20 km from Sorata on road to Achacachi, steep road bank, 3450 m, terrestrial, 10.12.1980, Balslev 1096 (LPB); Prov. Murillo, Valle de Zongo, 3810 m, terreno cespitoso rocoso con algunos arbustos cerca de Laguna Viscachani, 12.01.1980, Beck 2822 (LPB); La Paz, 20 km from Sorata on road to Achacachi, steep road bank, 3450 m, terrestrial, 10.12.1980, Balslev 1096 (LPB). **MEXICO. Oaxaca.** El Pelado, Sierra de Oajaca, 2700–3000 m, 09.1842, F. Liebman 71b (UPS L-82699 – isolectotype).

Notes — *Stereocaulon pachycephalum* is chemically variable; the full chemistry includes atranorin, and fumarprotocetraric, lecanoric, perlatolic, sublimbatic and bourgeanic acids. According to Lamb (1977), when perlatolic acid is lacking, the material, represents the so-called 'deficient phase I'; if lecanoric, sublimbatic and bourgeanic acids are not present, it belongs to 'deficient phase II'. All Bolivian specimens are 'deficient phase II'.

When lecanoric acid is present, *S. pachycephalum* is very easily determined, as this substance is not recorded from any other *Stereocaulon* species. Samples lacking this metabolite can be mistaken in South America for *S. novogranatense* I.M. Lamb; however, these taxa are easily separated by the cephalodia, which are cristate (composed of flattened, plate-like segments) in *S. novogranatense* and clavate to globose and sometimes flattened in *S. pachycephalum* (Lamb 1977, 1978).

Morphologically, *S. pachycephalum* is very similar to *S. ramulosum*, but it differs mainly in its chemistry (fumarprotocetraric, lecanoric, sublimbatic, and bourgeanic acids are lacking in *S. ramulosum*), and its longer, more septate

ascospores (45–90 × 2.1–4.6 µm with 4–11 septa, compared with 23–60 × 2.3–4.5 µm with 2–5(–8) septa in *S. ramulosum*) (Boekhout 1982).

Stereocaulon pomiferum P.A. Duvign., Lejeunia Mém.14: 119. 1956.

Morphology — Primary thallus disappearing. Pseudopodetia to 7 cm tall, not branched at the base or with few erect branches, with short branchlets in the upper part, when young corticated, finally at the base decorticated, medially in different stages of decortication and in the upper part corticated, greenish-grey. Phyllocladial branchlets present, coralloid. Cephalodia protosacculate, containing *Nostoc*. Apothecia developed on knob-like receptacles on corymbose branches arising from the upper part of the pseudopodetia.

Chemistry — Atranorin, stictic and norstictic acids (in accordance with Lamb 1977, strain I).

Distribution and habitat — The species is widespread in tropical mountains in central Africa (e.g. Kenya, Uganda, Zaire), Asia (e.g. China, India, Japan, Nepal), and South America (Colombia, Mexico, Peru, Venezuela) (e.g. Lamb 1977, Boekhout 1982, Sipman 1992, Sipman et al. 2008). In this paper it is reported for the first time from Bolivia where it was found on exposed rocks at altitudes of 2200 to 3200 m.

Specimens examined — **BOLIVIA. Dept. Cochabamba.** Prov. Chaperé, Parque Nacional Carrasco, 130 km del camino antiguo de Cochabamba a Villa Tunari, 17°07′S 65°36′W, 2200 m, bosque humedo, saxicola, 10.10.1997, Bach 684 et al. (LPB); cerca de la represa de Corani, 3250 m, muro cerca Candelaria, roca, 27.09.1988, Arrázola (LPB). **Dept. La Paz.** Prov. Murillo, Cordillera Real, Valle de Zongo, Laguna Viscachani, 3810 m, terreno cespitoso rocoso con algunos arbustos cerca de Laguna Viscachani, 12.01.1980, Beck 2822 (LPB).

Notes — *Stereocaulon pomiferum* is chemically variable; four chemotypes can be distinguished (atranorin always present; the nomenclature of chemical strains and deficient phases follows Lamb 1977): (I) with stictic and norstictic acids, sometimes with porphyrillic acid (strain I), (II) with porphyrillic acid alone (deficient phase I of strain I), (III) with unidentified pigments (deficient phase II of strain I) or (IV) with norstictic acid without stictic acid (strain II). All Bolivian specimens belong to chemotype I.

Stereocaulon pomiferum is similar to *S. claviceps* Th. Fr.; they can be readily distinguished as *S. claviceps* produces effuse soredia on branch-apices, while *S. pomiferum* is esorediate (Lamb 1977, 1978).

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